JOURNAL

OCTOBER, 1933

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WORCESTER, MASS.

A. S. T. E. Journal

Published by the American Society of Tool Engineers

8316 Woodward Avenue

Detroit, Michigan

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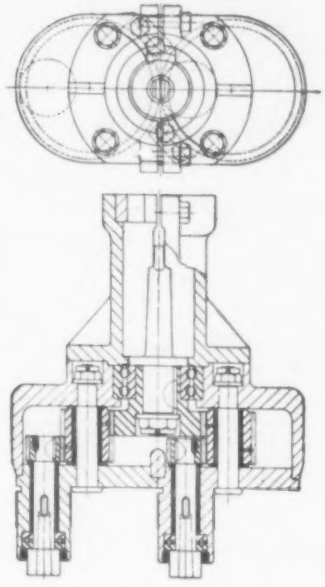

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No. 3—3 to 11"

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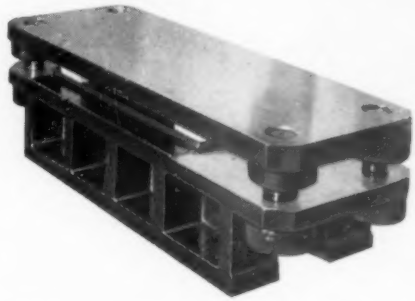

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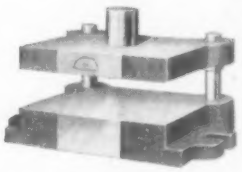

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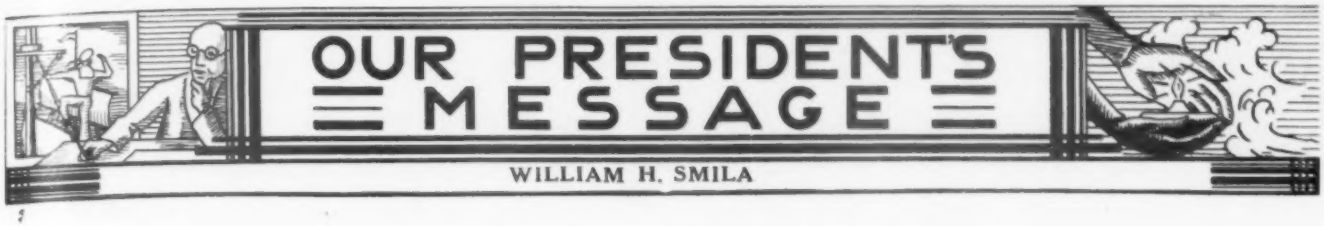


OUR NEW DIRECTORATE

ON August 21st, 1933, the polls closed on the election of a new directorate for the American Society of Tool Engineers. The newly elected directors will serve from October 1st, 1933 to October 1st, 1934.

The ballot submitted to the members for the selection of our directorate contained the names of 50 members who have been very active in the affairs of the society, and from this list the 33 members receiving the greatest number of votes were elected as directors. The Nominating Committee is to be complimented in their selection of names to make up the ballot, as every man named was well qualified to serve, anad while but two thirds could be elected for this year, there is no reason why those not elected this year should not serve on future directorates. I wish to take this opportunity to thank the Nominating Committee for their excellent selection and cooperation. The outgoing directorate was selected at a time when our membership totalled less than 100 members, but our membership has increased fivefold since that time, and we have enrolled many members which add much strength and knowledge to our society; hence, this new directorate should greatly exceed the old one. The names of the new directors together with position and company affiliation follow:

Name	Position	Company Affiliation
C. W. Balle	Chief Designer	Clayton & Lambert Mfg. Co.
Ed. Beyma	Tool Designer	Packard Motor Car Co.
Edw. Boone	Student	Detroit College of Applied Science
T. B. Carpenter	Ass't. Tool Supv's'r.	G. M. Truck Co., Pontiac
A. S. Cumming	Die Leader	Packard Motor Car Co.
E. R. De Luiz	Tool Designer	Rockne Motors Corp.
B. L. Diamond	Tool Designer	Ternstedt Mgf. Co.
B. C. Flemming	Chief Checker	Graham-Paige Motor Co.
Ray H. Farmer	Tool Engineer	Cadillac Motor Car Co.
Wm. J. Fors	Tool Engineer	
Wm. M. Gray	Sales Engineer	Congress Tool & Die Co.
Oscar E. Hovey	Machine Shop Sup't.	Lincoln Motor Co.
F. H. Hartlep	Chief Tool Designer	Timken-Detroit Axle Co.
F. L. Hoffman	Tool Engineer	Packard Motor Car Co.
A. H. Hoffman	Chief Tool Designer	G. M. Truck Co., Pontiac
O. B. Jones	President	Detroit College of Applied Science
Ed. C. Lee	Chief Tool Designer	Chrysler Corporation
Jos. P. Lannen	Master Mechanic	Graham-Paige Motor Corp.
Robert Lindgren	Chief Tool Engineer	Detroit Gear & Mach. Co.
Robert M. Lippard	Detroit Manager	Heald Machine Co.
Ford R. Lamb	Sales Engineer	Consolidated Mach. Tool Corp.
F. J. Morisette	Gen'l. Master Mech.	Dodge Bros. Corp.
W. C. Maier	Sales Engineer	Haberkorn & Wood
W. L. Newton	Chief Tool Designer	Graham-Paige Motor Corp.
Carl J. Oxford	Chief Engineer	National Twist Drill & Tool Company
Otto F. Poelke	Tool Designer	Chevrolet Mottor Co.
S. R. Read	Tool Designer	Chevrolet Mottor Co.
Robert E. Spurr	Ass't. Master Mechanic	Dodge Bros. Corp.
A. M. Sargent	Pres. and Gen'l. Manager	Pioneer Eng. & Mfg. Co.
J. A. Siegel	Ass't. Chief Tool Designer	Packard Motor Car Co.
W. H. Smila	Chief Tool Engineer	Chrysler Corporation
Jos. F. Slavik	Sales Engineer	Warner & Swasey Company
Walter F. Wagner	Tool Engineer	Lincoln Motor Co.

Twenty-two of the above mentioned directors served on the outgoing board. The eleven new directors will be warmly welcomed by the officers and balance of the new directorate, and it now becomes their duty to attend director's meetings and take an active interest in the affairs of the society. The society is depending on each director to do his part. The first meeting of the new directorate will be held on Thursday evening, October 19th, 1933, and it is hoped that we will have a one hundred per cent attendance. Regular notices of this meeting will be mailed from the Secretary's office approximately one week in advance. There are four regular meetings and three to six special meetings of the directors per year, and they are always held on the third Thursday of the month. Each director should arrange his social calendar so as to allow no interference with these meetings.

A. M. SARGENT

THERE are two committees amongst our group who are at the present time putting into motion plans which should materially assist the society in general.

The newly elected Chairman of the Membership Committee, Mr. Wm. J. Fors, has announced the names of the following men as members of his committee:

Mr. Frank Devine	Chevrolet Motor Company.
Mr. E. C. Herman	Packard Motor Cor Company.
Mr. Wm. M. Gray	Congress Tool & Die Co.
Mr. Ray Farmer	Cadillac Motor Car Co.
Mr. L. Dobson	Dodge Brothers
Mr. Ed. Branchofsky	Plymouth Motor Co.
Mr. R. Lindgren	Detroit Gear & Machine Co.
Mr. Chas. Thiede	Chrysler Corp., Jefferson Ave. Plant.
Mr. L. R. Anderson	Chrysler Corp., Highland Park.
Mr. Gordon Burkett	F. Jos. Lamb Company.
Mr. Leo Kaufman	Ex-Cell-O Aircraft & Tool Corp.
Mr. J. Wohlfeld	Buick Motor Company.
Mr. Wm. Peterson	Kelley Reamer Company.
Mr. J. P. DeMontigny	Chrysler Corp., Jefferson Ave. Plant
Mr. Kenneth Watson	At large.
Mr. Leonard Hodges	At large.

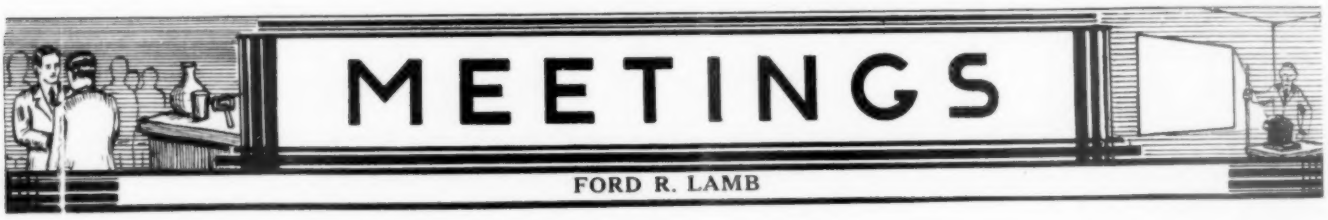
Their slogan to be: "Get a Member."

Their aim to be: "Membership of 1,000 before January 1st, 1934."

We firmly believe after looking over the roster of this committee that their aim will be attained.

The other committee which we have mentioned in previous reports as progressing nicely is the Standards Committee, under Mr. Frank Hartlop. We are given to understand that the preliminary sheet for the Official Standards Book will be published in the next issue of the Journal and will definitely outline the plans and procedure to be followed by this committee through the ensuing year.

The Industrial Relations Committee under Mr. Bob Lippard has apparently over-done its job. As mentioned in previous journals and as announced at the meeting, there is a demand for more men than are available in our "Positions Wanted Applications." We wish to emphasize again the necessity of all members who have previously applied for positions cooperating with this office to the extent of informing us of their new connections, and again to announce that if there are still any unemployed members that they at once get in touch with the Secretary's office and formally file an application for employment.



FORD R. LAMB

SEPTEMBER MEETING

THE September meeting of the A.S.T.E. was held at the Detroit Leland Hotel Sept. 14th, and was preceded by a dinner enjoyed by about 80 members. Approximately 250 members were present at the meeting. After the dinner President Smila opened the meeting and welcomed some of the guests, including F. G. Trailor of Buick, Flint; Mr. Adam rieves of Chevrolet, Flint; Mr. Edw. Newbacher of Chevrolet, Flint; Mr. F. A. Tompkins of Tomkins-Johnson, Jackson; and H. D. Corbin of Vulcan Engineering Co., Jackson.

Mr. Lippard, Chairman of the Industrial Relations committee, reported that the committee was having trouble placing men in positions because of the fact that members who have filed applications do not keep them up to date. It is necessary that all members who have filled applications to notify the Secretary's office when they accept a position, so that the file can be kept up to date with live applicants.

Mr. Smila announced that Mr. Fred Hoffman had resigned as Chairman of the Membership Committee, and Mr. William Fors was appointed as Chairman of this committee.

The first speaker on the program was Mr. T. Johnson of Whitehead & Kales Co., Detroit, who spoke on the subject, "Advantages of Rolled Steel for Machines, Bases, Die Shoes, Jigs and Fixtures." Next Mr. A. M. Candy, special welding engineer of Westinghouse Electric & Mfg. Co., Pittsburgh, spoke on the subject, "The Electric Welding of Machine Bases, Fixtures, and Welded Steel Buildings." The last speaker on the program Mr. J. W. Keyes, Engineer with Weldit-Acetlyene Company, Detroit, spoke on "Steel Shape Cutting," and conducted all who wished to go their plant, where he demonstrated shape cutting with an automatic flame cutting machine.

Resumes of the three talks are given below.

ADVANTAGES OF ROLLED STEEL FOR MACHINES, BASES, DIE SHOES, JIGS AND FIXTURES

Mr. Johnson:

Until a few years ago the only method available for making machine parts was by the use of castings, with all their attendant troubles, patterns, cores, blow holes, sand spots, excessive weight, hard spots, warpage, slow delivery, etc. The modern way, which has been brought about by engineering ingenuity in developing the flame cutting machine and improvements in fusion are welding, is to use rolled steel.

The material commonly used is hot rolled mild steel, (10-20), with a carbon content of from 15 to 25. This steel is more than twice as rigid as cast iron, cast iron failing at 20,000 pounds and steel yielding at 40,000 pounds. At 20,000 pounds cast iron stretches .004 of a unit and breaks, whereas steel stretches less than .002. Steel is particularly adaptable where the piece to be fabricated is in tension, steel being able to resist approximately seven times the tensile stress of cast iron.

Rigidity is one of the most essential features of machine construction, and rolled steel having more than twice the rigidity of cast iron makes a very desirable material for this type of work. It is only in comparatively recent years that flame cutting and fusion welding have been brought to sufficient perfection to enable rolled steel to be used economically for this work. As Mr. Keyes of Weldit-Acetylene Company will later demonstrate, all kinds of shapes can be readily burned out of any thickness of steel with a very smooth edge.

Advantages of rolled steel are many besides strength and rigidity. The patterns and cores are done away with, thus of storing old patterns and the cost of insurance on same, eliminating their cost, and also the cost and inconvenience Delivery is another item that favors rolled steel. We have made delivery many times of machine bases and complicated machine shoes in three days, some of the smaller ones requiring even less time.

One thing that should always be kept in mind is the fact that changes can be made at any time, either in the course of construction or at any time later, even after the machine is completed. All that is required is a cutting torch and a welding machine.

A rolled metal is the most uniform metal obtainable, free from hard spots, blow holes, and sand pockets; this consequently permits of easier and more rapid machining.

The greater strength and rigidity of steel allows a saving of weight to be effected. Also there is no need to thicken members to allow hot metal to flow; ;;this effects another saving in weight. With rolled steel the designer specifies exactly the amount of metal required to do the work involved.

Summarizing the advantages of rolled steel, we have: greater strength, greater rigidity, lower cost, quicker delivery, lighter weight, a more uniform metal, the ability to make changes at any time, no patterns to make, no storage space for patterns needed, no insurance to pay on stored patterns. So much for the advantages of rolled steel. Let us now consider the procedure to be adopted in making a rolled steel machine part.

Starting with the design, we have found that many of the designers shy at using rolled steel on account of not being familiar with drawing up a job that way. This is a very small objection, as any reputable concern specializing in the manufacture of rolled steel machine parts can use a drawing showing the piece designed as a casting, or if the piece is too complicated to handle that way they have engineering facilities to quickly change the drawing for use with rolled steel. However, nine times out of ten a few notations with a red pencil will change a drawing of a casting to a drawing of rolled steel.

When you have the opportunity, while designing a job, it will pay to have one of the reputable manufacturers of rolled steel machining parts send an engineer to advise your designers on the best way to utilize rolled steel on the particular job involved. Remember, for a rush job, design the way you are most accustomed to, and any good fabricating shop can either use your drawing or adapt it for rolled steel in a very short time.

These foregoing remarks regarding design are mainly intended for rush work until the tool designers get more familiar with rolled steel sections. Where there is time and opportunity to study the job from the start with the thought of using rolled steel, full advantage can be taken of the many shapes that are rolled. This will often mean that a rolled steel job will look entirely different to what it would as a casting.

Where the job is designed from the start with rolled steel in mind a much larger saving can be effected than by just changing a cast iron design to rolled steel. However, for the present, until your designers are more familiar with the great variety of shapes that are rolled, it might be as well to design as you are accustomed to and where possible have a rolled steel man advise as to how best to use rolled steel sections.

The workmanship on this type of work must be of the highest order; first-class flame cutting, bending, and welding equipment are essential. It is also necessary to carry a large stock of all sizes of steel. I do not propose to say much about either the flame cutting or the welding. I will leave that to Mr. Keyes and Mr. Candy.

Eliminating the cutting and the welding from this talk leaves me only the forming and the normalizing to explain to you. As far as bending steel is concerned, with the right equipment and the men who know how to use it, steel can be bent as required to accentuate the appearance of any job. You will notice on the pictures of the machines we have made that sharp corners have been eliminated. The corners can be bent to any radius you desire. This greatly increases the appearance of the machine besides leaving only two welded seams visible.

Where good appearance is desirable or of vital importance, the welds can be peened smooth, this besides enhancing the appearance makes the grain structure of the weld closer and the job absolutely water-tight, a primary consideration on a machine base which has the tank for the cooling fluid built in as part of the structure. The peening also helps to normalize the local welding stresses; however, this does not eliminate the necessity of relieving the stresses in the whole structure.

Perhaps the most important step in using rolled steel for machinery is correct normalizing. There are stresses set up in the steel due to rolling at the mill, then we add more stresses by the welding; and for any accurate job that has to be machined, these stresses must be relieved.

A temperature of 1200 degrees Fahrenheit should be maintained for one hour for every inch of thickness to be normalized. We have made several tests at various temperatures and have found that the above formula removes the stresses and does no form excessive scale.

I propose to turn the meeting over now to Mr. Cany of Westinghouse, who will tell you about the welding. Then Mr. Keyes of Weldit-Acetylene will explain the flame cutting to you, after which we will be glad to answer any questions that you may have. After this meeting those of you who are interested may walk two blocks along Bagley Avenue to the Weldit-Acetylene plant where there will be a demonstration of flame cutting.

THE ELECTRIC WELDING OF MACHINE BASES, FIXTURES AND STEEL BUILDINGS

Mr. Candy:

Mr. Chairman and members of the A.S.T.E. and guests: When I saw all the very interesting slides that Mr. Johnson has shown it makes me wonder. When I saw the program, I thought possibly I had made a mistake in lining up the series of slides I did. I hadn't spent quite as much time on bases and jigs and fixtures as on some other parts of our work. However, after seeing what you have seen, I believe that a little variation may not be so far amiss after all.

Just to give you a sketchy picture of the extent to which welding is used, I am going to take just a few minutes of your time to follow through the daily routine of an average business such as we have in New York City for example, and show you how it is possible to come into contact with welded products a great many times in the course of a day's time.

The gentleman of whom we are going to think now lives in the upper New York district and commutes back and forth from his office to his home every day. Our friend arises in the morning after a very refreshing night's sleep, from an all welded metal bed, goes into the bathroom and draws water from welded pipes. Then he goes down to breakfast where his wife is pouring his coffee from an all welded coffee pot. He has waffles from a welded waffle iron. Then he goes to the garage and gets into his car which has a great many welded parts, spark plugs, spokes in the wheels, etc. He jumps into his car and glances at the gasolene gage and sees that needs some gasolene—so he decides to stop at his favorite station. There the gasolene is drawn from a welded tank under ground through a welded pump. After filling the tank, he passes down the street, passing the place where welded tanks are produced. At the terminal of the subway system, he at this point parks his car in an all-welded metal garage and waits for the elevated train. The latter has been very greatly repaired by the use of welding. He proceeds to the City and then goes into an all-welded office building where he has his office. He gets into an elevator which is driven by welded generators. He walks into his office and hangs his hat on an all-welded hat rack. He then goes over to his all-welded desk and chair. In a few minutes he gets a telegram advising him that he must be in Hot Springs, Va., for a conference that afternoon. Well, the only way he can

get there now is by airplane. So he takes the steam train which has many welded parts and arrives at the flying field on Long Island and gets into a welded airplane. He arrives at Hot Springs and goes to an all-welded hotel. After the conference the men go down to the all-welded locker rooms and put their clothes in all-welded lockers. After an enjoyable afternoon of golf and a grand dinner, he retires in an all-welded bed.

Now all of these things and hundreds of others that might be mentioned are the result of the work of broadminded engineers who are also interested in new ways of doing things and improving their products. All of these things any many others are produced by thinking of new ways of doing things instead of following old methods.

We have gone into welding quite extensively and we have attempted to develop many new things. Welding has been tried out. It has proven to have merit in either reduced cost or weight or speed in producing the articles. If we can have the lights turned out, I am going to go through the slides, showing you some ideas of the fundamentals in welding. If the job is not designed from the floor up, the greatest advantages cannot be reaped from the welding business. It is surprising to see how many cases where there was no real engineer and no design work has been done. The results are surprising. The product does not show the advantages that are entirely possible from the welding operations. That is true with welding as it is for riveting.

Mr. Candy then showed slides of anvils for generators and motors, motor frames, bed plates—here he showed several slides and explained the different stages of construction. He said that the Canadian plant had conditions to meet that are much different than in the United States. They don't have access to the large variety of rolled steel that we have in the States and as a result they have much more to contend with. The Westinghouse Company feels that the welded machines are "not so bad looking."

He showed pictures of A. C. M. motors and vertical waterwheel generators; pictures of buildings in Pittsburgh where the Company has made repairs or additions and used welding. There was a large 7,000 h.p. synchronos motor for one of the steel mills in California, orders for which were given on the basis of ninety days' delivery. He said the motors (two) were started on delivery on the eighty-ninth day, which would have been impossible had casting instead of welding beenused.

Mr. Candy told how they use the scrap material for fixtures around the plant at Pittsburgh. He showed a group of drill jigs, jigs for motor rotating or winding operations. Also the Research Laboratory in Pittsburgh, where instead of using rivets they used welding. He showed charts showing what kind of materials to use and not to use, etc.

STEEL SHAPE CUTTING

Mr. Keyes:

We all are familiar with the hand cutting or acetylene cutting process and know the aid it has given industry, but as a mechanical directed tool it becomes a necessity in a great many shops.

process is a far reaching development in the field of machine

Flame cutting by the oxy-acetylene or some equivalent construction and it particularly is responsible for the entrance of rolled steel into this market.

Before this process was perfected, the only method of cutting steel was by shearing or machining. Shearing was limited to thicknesses of about ¾ of 1 inch where reasonably good edges were required and machining was very expensive. If the contour was irregular, the cost of machining was almost prohibitive.

By flame cutting practically all thicknesses of metal can be cut and with reasonable accuracy. For 2-inch plates the cutting tolerance can be held to plus or minus 1/32 to 1/16-inch and for plates or slabs 24-inches thick, plus or minus 3/16 inch.

Practically all steels used in machine construction can be flame cut without injury to the physical qualities of the metal, but in the higher carbon steels they are preheated before cutting and normalized after cutting.

Automatic machines are available for straight and circular cutting, and flame cutting for irregular shapes.

I am going to stop here and ask you all to come with me down to the plant where we will give you a demonstration of cutting.

NEXT MEETING

THURSDAY, OCTOBER 12, 1933

DETROIT LELAND HOTEL, MAIN BALL ROOM—8 P. M.

Lecture on "Tools of Burglary," to be delivered by Dr. Henry L. Coles, head of Dept. of Chemical Engineering at University of Detroit, formerly a member of Columbia University faculty. Dr. Coles' affiliation with the Mosler Safe and Vault Co. as vice president, particularly qualifies him to present a most interesting talk on the manufacture of safes and vaults as well as the design and building of burglar's tools, an industry that very few people knew existed.

A lecture on "The Great Muscle Shoals" accompanied by moving pictures will be presented by Needs Bros. & Co. of Detroit, who are pioneers in the peveloping of properties at the shoals. Speaker—Mr. Byron W. Orth.

The above subjects are expected to draw a very large attendance and the committee has made arrangements to seat a large crowd comfortably.

JUNIOR NIGHT

Thursday, October 26th, 1933, Eight P. M.

Detroit College of Applied Science

8203 Woodward Avenue

Speaker: Mr. C. W. Balle.

Subject: What Juniors Should Know About Die Making.

PROBLEM STUDY

Wednesday, October 18th, 1933, Eight P. M.
Detroit College of Applied Science
8203 Woodward Avenue

The Junior Activities Committee feels that there are many A.S.T.E. members, both Junior and Senior, who would derive great interest and benefit from these Problem Study evenings, but who have as yet not taken the trouble to attend one of these meetings.

Juniors and Seniors, come out to our October meeting! We are sure you will consider the evening well spent. Something may come up at the meeting that will materially help you in some of the daily problems you meet in your work.

TECHNICAL

JOHN M. CHRISTMAN RAYMOND J. WALTER W. J. McKEEN

STRENGTH OF MATERIALS

By JOHN M. CHRISTMAN

Solution of problem in preceding issue:

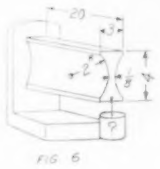


FIG. 6

Using a factor of safety of 3 and a tensile strength of 80,000 lbs. per square inch, what load will be safely supported in Fig. 1?

According to the explanation in the preceding issue of this Journal, the first step is to find the section modulus of a similar figure one inch high. By the following, a section modulus of .066 is obtained.

A = .57 × .081 = .046
B = .31 × .049 = .015
C = .16 × .025 = .004
D = .08 × .009 = .001
E = .03 × .001 = .000

Total .066

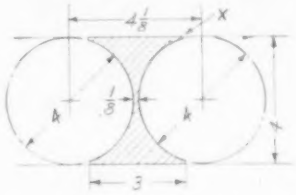
Since the shape in the problem is four times as high, and since the section modulus varies as the cube of the size, the section modulus in the problem is 4 × 4 × 4 × .066, or 4.22.

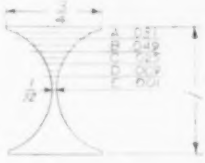
Quite often, the section moduli for unusual shapes can be obtained by considering them as made up of sections whose moduli are listed in handbooks.

For example, the shape shown in Fig. 2 is nearly equal to a rectangle 4⅛ inches wide and 4 inches high, minus a 4 inch diameter circle.

This gives a section modulus of (4⅛ × 4 × 4 × 1/6) — (4 × 4 × 4 × .098) = 4.7. (N.B.: 1/6 is the section modulus of a 1 inch square section.)

It can readily be seen that the section modulus 4.7 is somewhat greater than the theoretical figure, because of the points X, but this answer or the one shown above will





unquestionably be at least 90 per c ent correct. Considering that a factor of safety of 300 per cent is used, this error is negligible.

A section modulus of 4.22 means that a weight of 4.22 lbs is required to cause a stress of 1 lb. per square inch in the extreme fibres when the bar is 1 inch long, but since the bar is 20 inches long, a weight of $\frac{4.22}{20}$ lbs., or .211 lbs., will be required to cause a 1 lb. stress.

Since the tensile strength of steel is 80,000 lbs., a weight of .211 × 80,000, or 16,80 lbs. is required to break the bar.

Using a factor of safety of 3 the answer is $\frac{16.880}{3} = 5.626$ lbs.

NEW TOOLS AND PROCESSES

B. L. DIAMOND HAROLD GILLER

SPRING PLUNGER AND CLAMP

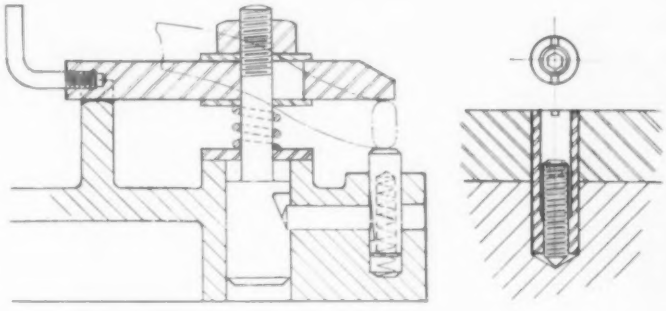
THE accompanying sketch shows an arrangement for locking a spring plunger and applying a clamp with one operation.

The part being held is a light cast iron piece with machined surfaces at one end which are used for locating.

The portion of this casting shown in the sketch is a yoke of thin section extending a bit to one side. Because of the lightness of the sections, it was deemed necessary to support this yoke. The clamp and plunger shown were used.

In operation, the part is loaded in the fixture and clamped against the machined surfaces. The spring under the plunger holds it in contact with the part. When the nut is tightened the stud is drawn up, forcing the locking pin against the plunger and locking it securely. The action of the nut then is to compress the spring under the clamp, and clamp the work against the plunger.

This proves very satisfactory as the work is held securely without setting up any clamping strains.



VARIATION OF THE THREADED DOWEL

This dowel is drilled out and tapped at the lower end to a depth approximately equal to the thickness of a standard nut of the same thread diameter. The remainder of the hole is drilled out for screw clearance.

To draw the dowel, simply screw a set screw into the dowel and against the bottom of the dowel hole. The dowel will be forced out.

This is an advantage over the conventional externally threaded dowel in that the dowel can be driven flush with the surface of the steel, allowing its use where a projecting screw dowel can not be used.

MILLING CUTTER POWER REQUIREMENTS

By O. W. WINTER

PREFACE

THE writer supervised a research project a few years ago on the question on the power required for milling. This project was under the joint auspices of The Cincinnati Milling Machine Co. and the Ohio State University.

The power required is a very important factor in rough milling cuts and is usually the factor limiting the amount of feed possible and the resulting production. It is absolutely essential when making production estimates that the power required be checked with that available.

The writer feels that the following paper is of considerable importance and trusts it merits the attention of Tool Engineers.

INTRODUCTION

There is probably no phase of engineering wherein more has been accomplished with proportionately so little exact knowledge of the subject, as in the field of machine shop practice, particularly metal cutting. Another way of stating conditions is that there is probably more guessing done in machine shop practice than in any other phase of engineering.

We do not necessarily criticize this condition, as we believe any theory must be tempered with practicability with due consideration of the cost in dollars and cents of applying the theory and consideration of the benefits derived. Too much theory is entirely possible.

Yet there has always been and still is to a certain extent, a need for more exact knowledge of metal cutting. There have been some very commendable contributions on the subject, but we believe there is much more work to be done.

One of the least understood metal cutting operations is milling. There are reasons for this. In the study of metal cutting, certain important variable factors must be considered and controlled. In milling, as compared with turning or drilling for example, there are an unusually large number of factors to be considered.

VARIABLE FACTORS

It is generally agreed from past investigations of the subject of milling and is confirmed in many cases by this project, that the following variable factors affect the efficiency of a milling cutter, or rather, the power required to drive a milling machine.

1. The Efficiency of the Machine and Driving Motor (if motor driven).
2. The Material being Milled.
3. The Milling Cutter Design.
   a. Number of teeth in cutter.
   b. The shape of the teeth, i.e., rake, spiral and clearance angles.
   c. The amount of chip clearance between the teeth.
4. The Nature of the Cut.
   a. Cutting on face or periphery of cutter or both.
   b. Direction of cutter rotation relative to table feed.
   c. Chatter.
5. The Metal Removal.
   a. Table feed in inches per minute.
   b. Width and depth of cut.
6. The Shape of the Chips Removed.
   a. Feed per tooth.
   b. Depth of cut.
   c. Direction of cut.
7. The Cutting Lubricant.
8. Condition of Equipment.
   a. Condition of cutter edge.
   b. Condition of machine.

This is an actual total of 14 variable factors with no effort toward undue ramification.

In order to properly cover only a practical portion of these factors it was necessary to make approximately 35,250 tests to cover the efficiency of 5 type of cutters milling Cast Iron, 4 type milling Nickel Chromium Steel, 4 type on Cast Duralumin. This was originally represented on 244 simple type charts condensed to 32 for this bulletin.

FUTURE PROJECTS

To cover the field entirely, approximately 230,000 tests should be made on each material studied. This would involve 9 sizes and designs, each of 5 types of cutters, 45 in all, taking tests of 16 different sizes cuts per cutter at 10 different feeds and 4 speeds and 4 readings for every combination of the above. In addition to this, all tests should be duplicated with cutter rotation with the direction of table feeds as well as against or, both up and down cutting.

Also on those materials possible similar tests should be made using various cutting materials other than high speed steel for which the above is intended. The practical value resulting from such a coverage of tests wherein not only total power required, but pressures developed on the work are noted should warrant the time and expense involved. Observations on cutter life should also be made.

The condition under which these observations were made, it will be seen later, duplicate as close as possible present day milling practice in regard to cutter design, cutting lubricant used, size of cuts, speeds and feeds encountered, etc.

PURPOSE OF THIS PROJECT

This particular project investigates certain variable factors from a basic theoretical standpoint, but its primary purpose it to make available to engineers and shopmen a convenient, quick, yet accurate and reliable means of determining the following:

1. In production estimating.
   a. The power required to use a particular rate of feed.
   b. The size of standard machine needed.
   c. The size of driving motor required.
   d. The feed rate allowable with a specific machine and hence the production obtainable.
2. In designing.
   a. Variable feed cams for either hydraulic or cam feed milling machines.
   b. Size of motor required or drive parts for a special milling machine.
3. In the shop.
   a. Determining if millers are being used to capacity.
   b. Determining if they are being overlatded.
   c. The maximum allowable feed rate for any job in question.

SCOPE OF THIS PROJECT

The project covers the following materials and cutter:

I. Cast Iron.
   1. Shell End Mills.
   2. Face Mills.
   3. Half Side Mills.
   4. Spiral Slab Mills.
   5. Slotting Cutters.

II. Nickel-Chromium Steel (SAE Nos. 3125, 3130, 3135 and 3140).
   1. Shell End Mills.
   2. Half Side Mills.
   3. Spiral Slab Mills.
   4. Slotting Cutters.

III. Cast Duralumin.
   1. Face Mills.
   2. Half Side Mills.
   3. Spiral Slab Mills.
   4. Slotting Cutters.

IV. Wrought Duralumin.
   1. Face Mills.
   2. Spiral Slab Mills.
   3. Slotting Cutters.

METHODS AND GENERAL RESULTS

In the following each previously listed variable factor is discussed and it is shown how this project recognized and accounted for the same.

I. The Efficiency of the Machine.

The ratio of the amount of power put into a milling machine and the amount delivered to the cutter is a factor that varies with different type and makes of machines. In addition to this the efficiency of the driving motor is a variable factor over different power demands.

One of the first steps in this project was to determine the net efficiency of the driving motor, and the milling machine used, over all speeds and at increments of one horsepower. These results were charted as shown in the example. After half of the cutting tests were run, these efficiency tests were repeated to serve as a check and were confirmed.

The equipment used, consisted of a prony brake mounted on the spindle nose of the milling machine. Through this we were able to determine the horsepower output of the milling cutter versus the watt input to the machine driving motor, measured by a sensitive wattmeter. This was done for all spindle speeds used and from zero to the maximum horsepower available.

It is a known fact among milling machine builders that the power required to feed the table is slight compared with that needed to rotate the cutter. For this reason the efficiency tests of the spindle drive and motor were deemed sufficient for all practical purposes.

In the charts that follow, the horsepower shown is that required **at the milling cutter.** To this figure should be added 10% to 20% additional depending on the design of the milling machine spindle drive under consideration when the power required to drive the machine is desired. Conversely the same amount should be deducted from the power available when the feed rate allowable is being computed.

(TO BE CONTINUED NEXT ISSUE)

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OPERATION PLANNING

F. L. HOFFMAN

(Continued from last issue)

OPERATION sheets are issued to the various departments which are designated to manufacture the part. They are used by the foremen to make tool follow-up lists, so that they may get the tools into their departments from the tool room or purchasing department in the proper sequence. These tools are tried out on the machines specified, and parts are made with them and checked against the blue print of the part and the operation sheet.

As soon as the tool produces accurate parts, it is put into production, as are all the following tools. The operation sheet is used by the foreman to determine his man load, using an estimated time as a bosis for determining the number of men required. Men are assigned to execute various operations and again the operation sheet is used as a guide and tool list. When all the operations shown on the sheet are completed the part is inspected and passed on to the next department for further operations, or to be used in an assembly which is also shown on the sheet.

Time slips are made out by the departments showing the part name, number, the department executing the work, the operation number, elapsed time for the operation, and the man's name and roll number.

Perishable and commercial tools are ordered by the manufacturing departments from information furnished on the operation sheets.

Operation sheets are furnished to the estimating department which supplies the estimated time for each operation in order that each department may compute its man load, and also an estimated cost of the completed product. This estimate will be used as a basis for computing the selling price.

Operation sheets are used by the time study department in its study of the part in operation in the department. An actual time is arrived at which is later used by the cost department to get the actual cost of the part and as a basis for the labor load of the department. In this study, operations may be combined or split up in such a way that the greatest efficiency may be obtained.

Operation sheets are used by the production control department in the control of stock in order to meet the requirements of the assigned program. Parts are scheduled out of each department at a uniform rate so that no shortages or overproduction occur. Control boards are posted daily so that any change in the operation sheet showing a different routing for the part is immediately recorded.

Operation sheets are issued to the cost accounting department, which uses them to compile an accurate and actual cost of manufacturing the product. These sheets are especially valuable and necessary in the cost division of plants which require a perpetual cost of their product according to changes which are shown on the operation sheets due to manufacturing requests, saving changes, or changes in the parts which originate in the engineering department.

The stores division is supplied with operation sheets so it may know where to store parts and how to distribute them according to scheduled requirements.

The inspection division is furnished with operation sheets so that it may know what gages and fixtures are provided to inspect the part, and to see that all operations have been performed to agree with the operation sheet and part print. Parts which have passed inspection are then transferred to the next point shown on the operation sheet, by means of a transfer slip which is made out by the inspector who has approved the work. Copies of this slip are then sent to the office so that the workman may be credited with the stated amount of accepted work.

Operation sheets are issued to the service division so it may know where it can obtain certain parts, and in what condition they will be when received. These parts may be only partly finished by the manufacturing department and require finishing in the service devision. The operation sheets will show what tools are needed and all necessary equipment to make the part.

One can readily see the importance of operation sheets in modern manufacturing from an analysis of the above. It shows that operation sheets are the guide of many departments in performing their many and varied tasks in the manufacture of the things which surround us.

(To be continued next issue)

NEWS OF INDUSTRY

M. E. S. A. STRIKE

The tool and die makers strike which is in effect at the time of going to press with this article will no doubt delay the advance in general business and will probably effect most of us.

This strike originated in Flint, Mich., and we are informed that the strike was called in Flint when Industry refused to meet the demand for 1.50 per hour for die makers down to 1.00 per hour for machine operators and .90 per hour for helpers.

About one week later the tool and die makers in Detroit voted to strike and went out.

At the present time the employers in Detroit are helpless because the men here have made no demands. They just walked out in sympathy with the Flint boys.

Naturally an employer in Detroit can not be held responsible for the actions of an employer in Flint and can do nothin to cause a settlement there. They can only set back and wait until the Flint situation settles itself or until their employes make some demands of their own which can be considered.

The writer was unable to get a statement from the Mechanics Educational Society so was unable to learn whether they will make any demands in Detroit.

We can not help but believe that a closer relationship is needed between worker and employer. Surely most of our problems could be settled with out such losses as a strike entails.

We hope this strike will be settled before this Journal gets in the mail. If not plenty of work will go to other states with consequent loss to Detroit workers.

A.S.T.E. NEWS

LOLA CORBIN S. R. READ

Mr. Louis Bleecker of the Mechanical Industrial Engineering Company has accepted a temporary position with the Mullins Body Company, at Salem, Ohio.

Mr. O. W. Winter, our foreign correspondent, has from time to time sent us some very valuable information. The article appearing in another part of the journal is the same as is appearing in Russian technical papers, and we are promised more charts and articles to follow on Chrome Nickel Steels and Aluminum Alloys which have not been prepared as yet.

Mr. Winter informs us that at the end of November he will have a little more time to himself and will be able to complete the program of articles which he has outlined. We are pleased to note that the Russian government is kindly cooperative in permitting Mr. Winter to send us this statistical information for our publication.

We are also informed that Mr. Winter is at the present time engaged as a consultant on milling and grinding problems in general and is also serving the machine tool industry and cutting tool industry in a consultant capacity. His work consists of tool and fixture designing, consultation on various problems of organization and factory management, machine and tool design in the various plants, writing articles, giving lectures, and in general finding more to do than there is time to do it. He is at present working on the problem of establishing Russian Milling Cutter Standards. For this particular work he has approximately 20 engineers under his supervision. Mr. Winter is working in the various plants designing tools and fixtures or making cutters as well as establishing the necessary standards.

Apparently our particular industry is practically the same the world over, as from Mr. Winter's article we can assume that tool engineers in the U. S. S. R. are confronted with the same tool problems as are our own members locally, and without doubt obtain results according to the latest improved methods.

MANUFACTURING ECONOMICS

G. F. PETERSIMES

Owing to the limitations of space, and the superabundance of other material of unusual value to our readers, we regret that we shall be obliged to postpone the material prepared for this section to a later issue.

JUNIOR ACTIVITIES

FLOYD CARLSON

OCTOBER JUNIOR MEETING

MR. C. W. BALLE will be the featured speaker at the Junior Meeting to be held October 26, which is announced on the Meetings page of this issue of the Journal.

Mr. Balle at present is in charge of the engineering at Clayton and Lambert Manufacturing Company. In the past he has held such positions as tool designer, chief tool designer, checker, chief engineer, and tool engineer for such companies as the Ford Motor Company, Dodge Brothers, Packard Motor Car Company, Motor City Tool Company, and Hudson Motor Car Company.

The subject of Mr. Balle's talk will be "What Juniors Should Know about Die Designing."

These Junior Meetings are really educational and deserve to be better attended. Engineering students and young draftsmen should attend these meetings, as the speakers selected are authorities in their subjects, and cannot fail to give those present much invaluable information.

PROBLEMS

READERS of the A.S.T.E. Journal are invited to submit solutions to the problems here shown. They are tough nuts to crack, and will test the mathematical powers of Seniors as well as Juniors. Come, join in the game.

In Fig. 1 it is required to find the center of gravity of the cylinder with the drilled hole.

Fig. 2 shows a six inch steel column to be cut away to allow a pipe to fit perpendicular to it. Find the volume of the section cut away if the centerline of the pipe is on the circumference of the column.

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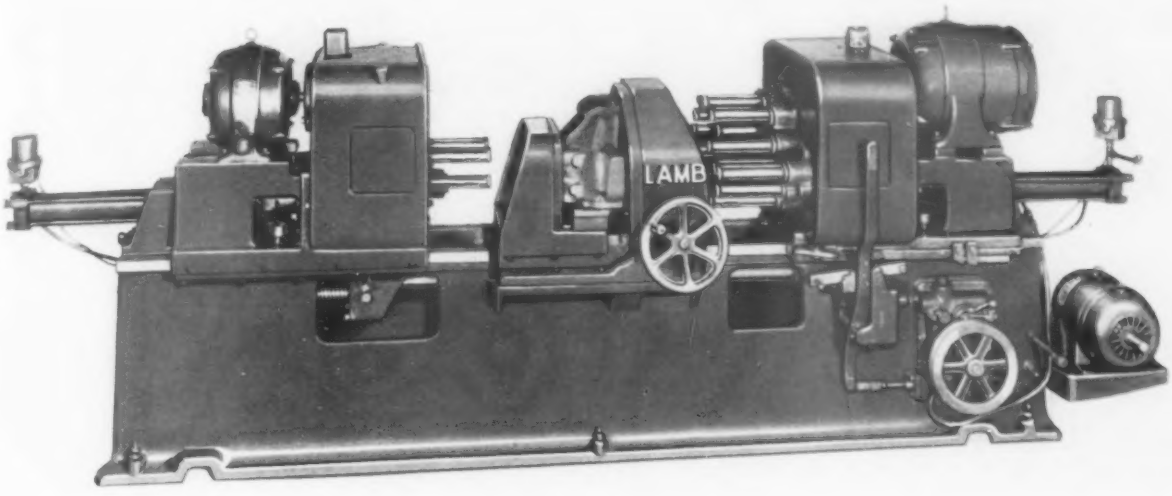
This photograph illustrates how an old type machine was fitted with Lamb Multiple Heads and Fixtures for drilling holes in clutch housing



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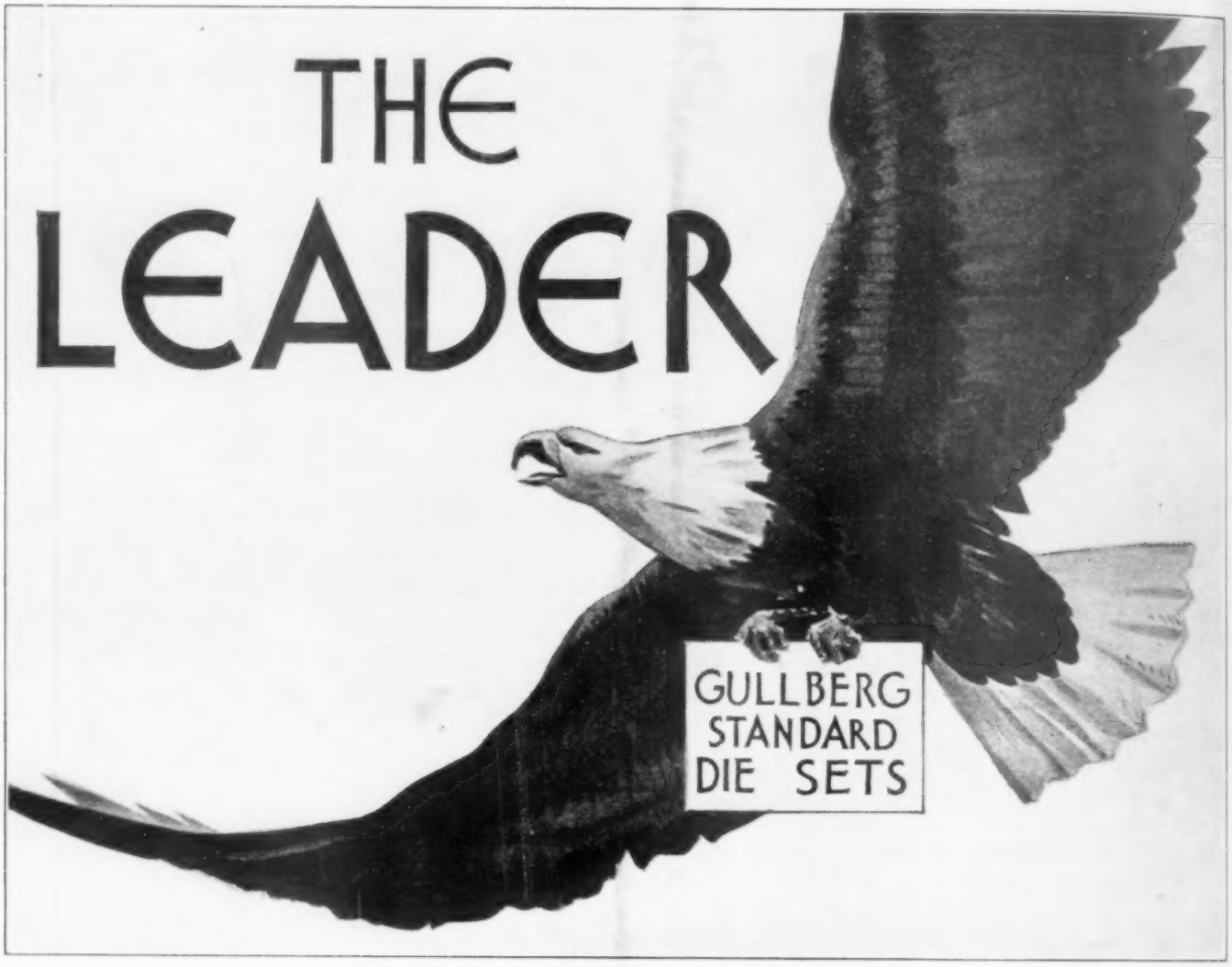

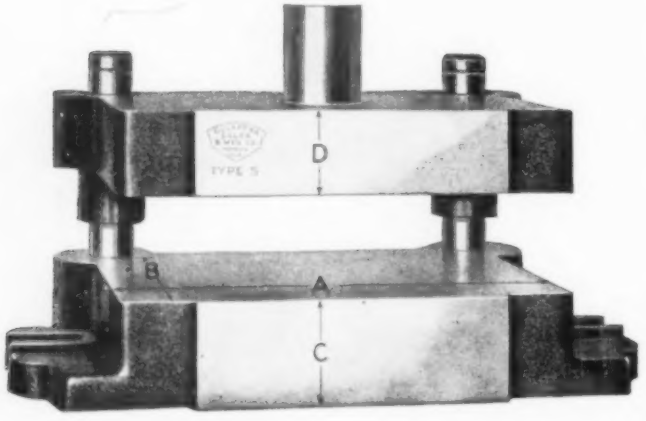

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